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Sub-SPEC (NE)

BOARD PRODUCT AND METHOD OF MAKING THE SAME

BACKGROUND OF THE INVENTION

Field of the Invention

Embodiments of the present invention relate to a coated board product and a method of producing the same.

Description of Related Art

In the field of producing paper products, one ongoing goal is to improve the quality of board products, especially boxboard, and the economy of producing the same.

Board is required to have a certain surface quality for ensuring a desired gloss and print quality, and a stiffness and tear resistance for securing the functionality of a package. Since board is produced in large quantities in a board mill, the efficient use of raw material is also important. However, these demands are somewhat contradictory to each other. Board can be provided with a sufficient gloss by calendering the board by compressing it in a nip, often moistened and heated in a certain manner. The surface fibers and coating of board are preferably pressed smooth by this compression, yet without compacting the middle ply of board. The compaction of a middle ply undermines board stiffness and reduces tear resistance. The compaction of a middle ply is often referred to as a loss of bulk. In this case, bulk is understood as being an inverse value to density and a loss thereof is thus equal to a densifying compaction of paper or board.

Since the process of making paper and board is highly raw material intensive, even a minor saving in raw material provides a major advantage over competitors. In this respect, a saving of just one percent can be considered a major competitive edge and the

investment restitution time is short. Saving raw material is also desirable for environmental reasons. By virtue of a reduced weight structure, the multiplicative effects of the board of this invention cover the product's entire life span, the reduced consumption of raw material resulting in a lighter container which ultimately creates savings also in shipping operations and in the way of a reduced amount of waste.

Packing boards are often coated or multi-ply structured. Basic board consists typically of three plies of fiber, wherein the top and back plies are made of bleached pulp. The filler ply consists often of mechanical pulp, typically groundwood (GW), but in many cases also pressure groundwood (PGW) and chemithermo-mechanical pulp (CTMP), or the filler ply can also be made by using broke. The face of board is generally coated twice and the back once. Coating and sizing are used for providing desired properties. A typical basis weight range for boxboards is 180-350 g/m^2. The necessary basis weight depends on a required stiffness of the container, a lighter board being sufficient for small boxes. Successful conservation of board bulk in surface treatment to produce thereby board of a higher stiffness results in savings of raw material and energy by enabling the use of board of a lesser basis weight. Typical applications for board include cigarette packages, pharmaceutical packages, postcards, cardboard covers for books, various food packages.

Boxboards are often smoothed with a Yankee cylinder prior to coating, which provides a good bulk and stiffness, the surface properties being also good, the drying shrinkage along the edges being likewise small, yet the use of a Yankee cylinder is limited by speed restraint, space demand for equipment and the enormous size of a Yankee cylinder in a high-speed machine. Another typical treatment method involves a wet-stack calender, the drawbacks of which include problems regarding runnability and a controlled application of water and, in addition, extra costs are incurred by the necessity of drying the board before and after a calendering process.

A machine calender is often used together with other calenders, the machine calender referring to a hard calender with no elasticity in its rolls. The use of a machine calender as the sole surface treatment method is not advisable. A soft calender refers to a soft-nip calender, wherein the calender roll has a surface which is elastic, the surface

having possibly a hardness in the same order as the surface hardness of wood, yet being elastic.

BRIEF SUMMARY OF THE INVENTION

The above and other needs are met by the present invention which, in one embodiment, provides a method of making a boxboard product having a smooth printing surface, a high gloss and stiffness in the boxboard with a lesser-than-before consumption of material, and avoiding bottlenecks and improving runnability in the production process. In one embodiment, the coated container board of the invention comprises two or more plies of fiber, wherein the outside plies consist of bleached chemical pulp and the inner plies of mechanical pulp or chemithermo-mechanical pulp or broke.

According to the invention, boxboard is treated with a long-nip calender prior to coating or during its coating process in order to upgrade the board qualities over what is known before and, in addition, the production runnability is improved and the production method is not subject to a speed restraint the same way as a Yankee cylinder. A long-nip calender suitable for making a board of the invention has been described, for example, in U.S. Patent No. 6,164,198 also assigned to the assignee of the present invention.

A calender suitable for the surface treatment of a board of the invention includes a fixed support element, around which is a tubular jacket. A heated counter-element is disposed on the other side of the tubular jacket from the support element, such that a web passes through between said counter-element and the tubular jacket. The fixed support element is provided with load elements, applying the jacket against the heated counter-element and thereby enabling a calendering process between the jacket and the counter-element. The jacket has its opposite ends secured to end walls mounted rotatably relative to the support element, the rotary motion of the end walls being delivered by a separate drive motor, which is independent of a motion of the fibrous web in order to avoid overheating of the jacket.

A method of the invention for conditioning the surface of coated or uncoated board with a surface conditioning device is in turn characterized in that the method comprises feeding a fibrous web through a long nip established by a roll and a counter-roll, the former being in the form of a tubular-shaped flexible jacket. Across the extent of

the nip the jacket deflects and thereby presses into contact with the counter-roll over a long stretch. The board treated with the method is lighter than currently available boards, while stiffness and surface properties are equal to those of currently available boards.

The solution enables a running speed substantially higher than what is accomplished with a Yankee-cylinder equipped board machine. In addition, the runnability is better, this also contributing to improved quality and reducing waste.

Web speed in the calender may be higher than 600 m/min, preferably higher than 800 m/min, and still more preferably 1000 m/min, yet lower than 4000 m/min. Thus, the calender does not restrict the speed of a board machine. The above-mentioned heated roll has a temperature of 150-350°C, preferably higher than 170°C, most preferably about 200-250°C. Linear pressure in the nip is within the range of 100-500 kN/m, preferably less than 400 kN/m, most preferably about 50-300 kN/m. Maximum pressure in the nip is 3-15 MPa, preferably less than 13 MPa, most preferably about 0.5-8 MPa.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

Having thus described the invention in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

FIG. 1 is a sectional view of a long-nip calender, provided with a long nip between an enclosed shoe calender and a counter-roll;

FIG. 1A is a partial enlargement of **FIG. 1**;

FIG. 2A is a partial sectional view of the device shown in **FIG. 1**, along the roll axis and depicting a drive mechanism; and

FIG. 2B shows the operation of press shoes in a longitudinal section.

DETAILED DESCRIPTION OF THE INVENTION

The present inventions now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the inventions are shown. Indeed, these inventions may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Like numbers refer to like elements throughout.

In **FIG. 1**, a board web **80** travels through an extended and heated nip **1**. The nip **1** is established by an enclosed shoe roll **10** present under the web **80**. Above the web **80** is a heatable counter-roll **22**. The enclosed shoe roll **10** comprises a flexible jacket **12** impervious to liquid. The jacket consists for example of fiber-reinforced polyurethane. The stationary fixed support element **14** carries at least one load shoe **18**. Between the load shoe **18** and the support element is an actuator **20**, such as a hydraulic cylinder, for urging the concave load shoe **18** and thereby also the flexible jacket **12** against the counter-roll **22**. Thus, the jacket **12** is forced out of its normal unloaded position **11** in a direction away from the center of the enclosed shoe roll. The jacket **12** is fastened at both ends thereof to end walls **24, 26**, thus creating a sealed compartment **13** (see **FIG. 2**). As shown also in **FIG. 1**, at least one detector device **99** is mounted in communication with the web **80** for detecting web breaks. The detector device **99** is connected to a control device **98** for controlling the operation of a calendering process in dependence of the web being broken or not.

As shown in **FIG. 1**, the heatable counter-roll **22** is accompanied by a disengagement mechanism, comprising a lever **95** pivotable by a hydraulic cylinder assembly **94** and provided with a pivot point **96** for pivoting the lever thereon. The disengagement mechanism presses the counter-roll **22** to an engagement with the nip **1** and disengages it from the nip **1**.

Between the load shoe **18** and the jacket **12** is supplied a pressurized oil, which develops a hydrostatic pressure throughout the nip and presses the jacket to an engagement with the counter-roll **22** over the entire extent of the nip **1**. At the same time, the oil protects the jacket from being damaged by lumps and a temperature rise.

In **FIG. 2A** it is shown that the end walls **24, 26** are rotatably mounted on stub shafts **16, 17** of the support element **14** (The end walls are preferably not integral but divided into a static part and a rotating part as shown in **FIG. 2B**). On one end of the stub shaft, a cylindrical shaft **32** is arranged rotatably via bearings **34**. A support column **36** is arranged to the cylindrical shaft via self-aligning bearings **38**, which allow spherical movement to allow the deformation/bending of the support element **14** when heavily loaded. One of the end walls **24** is fixedly attached to the cylindrical shaft. A drive transmission **40** is fixedly attached to the cylindrical shaft outside the end wall, in the

shown embodiment a cog wheel. The cog wheel is connected to a transmission **42** and in turn a drive **44**. A cog wheel **46** is fixedly attached to the cylindrical shaft inside the end wall. A drive shaft **48** is arranged inside the jacket and parallel to the support element **14**. The drive shaft **48** is supported by bearings **50** arranged in bearing houses **52** attached to the support element. At each end of the drive shaft, cog wheels **54** are arranged. Preferably these cog wheels have a prolonged toothed portion to allow axial movement of the intermeshing cog wheel which is attached to the end wall. A further cog wheel **56** is fixedly attached to the second end wall **26** inside the jacket. Both cog wheels inside the jacket mesh with the corresponding cog wheel on the drive shaft. The second end wall **26** is rotatably arranged on the second stub shaft **17**. The second stub shaft is in turn fixedly attached to a second support column **58**.

The operation is as follows. During normal operation, the driven heated roll **22** is in interaction with the fibrous web and the flexible jacket **12** by a desired pressure being exerted by the load shoe **18**, thereby causing a friction based drive of both the fibrous web and the flexible jacket. Accordingly, during normal operation the forces exerted in the nip provide for rotation of the enclosed shoe roll.

Only in specific occasions, it will normally be desirable to operate the independent drive of the enclosed shoe roll **10**, for example when starting up the calender. If the calender should be started without first speeding up the flexible jacket **12**, this would inevitably cause damage to the flexible jacket due to overheating. Furthermore, it would also be deteriorating for the fibrous web, since at the moment of start it would develop exceptional tension forces in the fibrous web. Accordingly, the independent drive arrangement of the enclosed shoe roll is to be used for instance at the start-up of the calendering surface. At the start, the nip gap is not closed, but the roll **22** has been moved out of contact with the nip **1**. Before moving the heated counter-roll **22** into the nip, the drive arrangement **44** of the enclosed shoe roll **10** is activated to accelerate the first end wall **24** via transmissions. The rotation of the end wall causes the inner first cog wheel **46** to rotate, and subsequently the drive shaft **48**. The drive shaft transmits the rotation to the second end wall **26** via the second inner cog wheel **56**. The both end walls are thus accelerated and rotate at the same speed until a desired peripheral speed is obtained, which is normally equal to the speed of the fibrous web. The nip is

closed by activating the hydraulic piston **94** to pivot the lever **95** and thereby moving the counter-roll **22** into the nip and subsequently the load shoe **18** is urged against the heated roll **22** by its actuators **20**. Once the calender functions in the desired manner, the drive arrangement of the enclosed shoe roll can be deactivated and the press roll driven in a conventional manner by friction within the nip **1**.

In **FIG. 2B** there is shown an alternative embodiment of the drive arrangement for an enclosed shoe roll. This embodiment uses friction for the transmission of rotational forces.

FIG. 2B also shows a design of arranging the support element and the end walls. The end walls are divided into inner parts **24A, 26A** connected non-rotatably to the support element **14**, a rotational part **24B, 26B**, and a bearing assembly **24C, 26C** therebetween. The support element **14** is at its ends arranged with self-aligning bearings **23, 25** to allow a deflection of the support element **14**.

In the figure there is shown a drive **44** having a shaft **19B**. On the shaft **19B** is mounted a disc **19** having a rubber layer at its peripheral end **19A**. The outer ends of the flexible jacket **12** are fixedly attached between an annular ring **15**, acting as a replaceable force transmitting device, and the periphery of each end wall. The ring **15** is fixedly attached to the end wall. On the inside of the rotational part **24B, 26B** of each end wall there is fixedly attached a cog wheel **46, 56**. The drive arrangement **44, 19** is movable in and out of contact with the force transmitting device **15**. When it is desired to accelerate the enclosed shoe roll **10**, the drive arrangement is moved such that the rubber layer **19A** comes into frictional engagement with the force transmitting device **15**. The cog wheel **46** and the drive shaft **48** transmit the rotation of the end wall **24** to the other end wall **26** by the cog wheels **54, 55 and 56**, which at the same time function as a synchronizing device. Hence, both end walls **24, 26** are operated as described in reference to **FIG. 2A**. **FIG. 2B** further illustrates in a schematic view one functional embodiment of the load shoe **18**. Generally, the load shoe **18** is not disposed diametrically relative to the drive shaft, but perpendicularly as in **FIG. 2A**.

Tests conducted by the assignee indicated that, in test batches manufactured by a long-nip calender as described above, the board could be provided with a ratio of bulk

and smoothness better than in currently available types of board. Thus, according to measurements, the goals of the invention are achieved.

Shoe calenders can be driven at high speeds and, furthermore, by the application of an elevated temperature, e.g. about 250°C, and by taking into account a long dwell time in the calendering zone, the resulting gloss finish will be equal to what is achieved in a slower solution using a Yankee cylinder. In addition, the board is provided with improved bulk. In addition to aspects contributing directly to board quality, the results include savings of production space in a mill, the elimination of a production limiting Yankee cylinder, and the provision of a more manageable, more easily controlled system.

In view of producing board of the invention, surface moistening can be provided prior to calendering. However, the inventive board can also be produced without surface moistening.

Conducted tests showed that better surface properties were obtained for board with equal bulk. Test runs were performed on board which was calendered with the above-described long-nip calender without smoothing it with a Yankee cylinder:

Methods Measured For The Same Grade Of Board

	Precalendering Conditions			Board Properties			
	Temperature °C	Linear pressure kN/m	Added water g/m²	Bulk cm³/g	Bendtsen roughness ml/min	PPS roughness µm	Hunter gloss
Yankee reference	-	-	-	1.83	22	1.4	35
Shoe calender	200	100	4	1.84	41	1.5	33
Shoe calender	200	200	4	1.82	25	1.3	32
Shoe calender	250	100	4	1.82	16	1.2	33
Shoe calender	250	200	4	1.82	17	1.2	32

In the test run, reference board and pilot-calendered board were coated twice in a blade coating station, the total amount of coating being about 24 g/m². The products received no final calendering.

Hence, without affecting bulk, the result showed less roughness and more gloss than what was achieved with the Yankee reference. Based on experience, the interpretation of test results represents a progressive step, regarding for example the quality and production economy of boxboard. In general, pilot tests provide results are somewhat less indicative than those achieved in the ultimate environment, so even on the basis of these preliminary tests, it is possible to draw a conclusion that the method is capable of producing board that is better than before and at the same time more easily and economically producible. In addition, the method is applicable to considerably higher speeds than a Yankee cylinder.

Many modifications and other embodiments of the inventions set forth herein will come to mind to one skilled in the art to which these inventions pertain having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the inventions are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.